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By molecular motion is meant, "the translatory motion of the centroid of the atoms that form the molecule, while as atomic motion we count all the motions which the atoms can individually execute without breaking up the molecule. Atomic motion includes, therefore, not only the oscillations that take place within the molecule, but also the rotation of the atoms about the centroid of the molecule." *

Thus it is conceivable that vital activities may also be determined by the *kind* of motion that takes place in the molecules of what we speak of as living matter. It may be different in kind from some of the motions known to physicists, and it is conceivable that life may be the transmission to dead matter, the molecules of which have already a special kind of motion, of a form of motion *sui generis*.

I offer these remarks with much diffidence, and I am well aware that much that I have said may be regarded as purely speculative. They may, however, stimulate thought, and if they do so they will have served a good purpose, although they may afterwards be assigned to the dustheap of effete speculations. Meyer writes as follows in the introduction to his great work on 'The Kinetic Theory of Gases,' p. 4: "It would, however, be a considerable restriction of investigation to follow out only those laws of nature which have a general application and are free from hypothesis; for mathematical physics has won most of its successes in the opposite way, namely, by starting from an unproved and unprovable, but probable, hypothesis, analytically following out its consequences in every direction, and determining its value by comparison of these conclusions with the result of experiment."

JOHN G. MCKENDRICK.

UNIVERSITY OF GLASGOW.

* Meyer, 'Kinetic Theory of Gases.' Translated by Baynes, London, 1899, p. 6.

DATA ON SONG IN BIRDS. OBSERVATIONS
ON THE SONG OF BALTIMORE ORIOLES
IN CAPTIVITY.

MUCH has been written in regard to the songs of birds, and no small part of the literature of the subject has dealt with the problem of the way in which many kinds of birds have acquired the distinctive song that characterizes each different species.

In the eastern United States many of us recognize, without seeing, the singer, on hearing the song of one of our commoner native birds. We say, 'A robin is singing,' 'Listen to the bobolink,' 'That is a song sparrow.'

Some who pay close and particular attention realize that individuals of a given kind have sometimes slight, though marked, variations in the method of song that distinguish them from the mass of their kind and characterize them as individuals which are readily known by their *peculiar personal song*. So we say, 'This robin is a good singer,' 'The note of that thrush is particularly pleasing,' 'That oriole has some harsh notes.' Such comments are indicative of the taste or appreciation of the listener and are only introduced here to emphasize two facts. First, that the song of all the individuals of a given kind of bird, as the robins, is so characteristic that we call it the robin's song, readily recognize it, and know that, in the main, all the robins of a given region have a common song, so much alike that we do not individualize the singer. Second, that now and again individual birds of a given kind, robins again for example, are readily distinguishable as individuals by some turn or phrasing of the notes that gives to the individual singer an identity as a particular robin, with an individual song, different, to a greater or less degree, from the mass of robins in the same region.

The question at once suggests itself: How is this characteristic song acquired?

Is it a matter of inheritance? Or does each robin learn to sing? Is it inherent in the species or is this song of the robin a matter of education?

A. R. Wallace and Lloyd Morgan especially have advanced hypotheses to account for the matter of call notes and song, and Mr. Morgan's work is based on many careful experiments that are set forth in his book, 'Habit and Instinct.' But, so far, I am not aware of any prolonged or detailed account of the study of this factor, as it develops with, and extends through, the life of a given individual, nor has a second generation been carefully watched.

The following experiment, though imperfect and by no means as exhaustive as could be desired, seems, however, worthy of record, as from it certain conclusions may be drawn. The notes accumulated extend over a period of nearly five years and are briefly as follows:

On July 7, 1895, I took from a maple tree at Annisquam, Massachusetts, a nest of the Baltimore oriole (*Icterus galbula*), which contained three very young birds. They were quite naked and showed no signs of wing or tail feathers. They appeared to be about five days old. As a record to refer to, one was killed and preserved in alcohol. The other two were carefully reared by hand and thrived well.

So far as I know, they did not hear, after coming into my possession, any birds sing, nor did any person whistle or sing to them.

At the age of between three and four weeks they were able to feed and care for themselves. They began then to fly from place to place about the room, and it became necessary to confine them in a cage. However, they were allowed the larger liberty of the sitting room for a portion of each day and were very tame and familiar, for a long period calling for food in the characteristic oriole way and begging with drooping

fluttering wings of any one who came into the room.

By August 1 they were fully fledged and the downy first plumage of the head and body began to be replaced by the compact and finished plumage of the first autumn. The wing and tail feathers were, however, not moulted at this time.

During the first week in October, the birds were taken by me to Boston. Here I lived in rooms on the upper floor of a four-story house where there were no other birds in confinement, so that no song of any kind was heard by the birds while at this place.

Now I began to appreciate that both were female birds and also noted great temperamental differences in the two. One was timid, and the other taking advantage of this characteristic, scolded and chased the timid bird both in the cage and when at large in the room. So by name I began to distinguish them as Driver and Timid, which last soon became Timmy, a name always associated in my mind with Baltimore orioles.

At this time they had a single call note very like that of wild birds, but with a slightly different quality difficult to define, more abrupt, musical and much louder. They also had the peculiar rattling chatter associated with orioles. These were all their notes and were uttered rarely, the infant appeal so prevalent during the first four weeks of their lives having disappeared with their babyhood.

During the next few months their lives had no marked events. Each day they spent much time out of the cage at large in the room. Threads interested them, and hours were spent by the two birds in sewing, for I can use no other word, threads and strings into the wire bars of the cage they lived in. Without any semblance of weaving a nest or attempting to shape one, the birds simply tied and wove the threads

into the wire until there were no loose ends. Ultimately thick bunches of thread and string on the bars characterized the cage.

I have told all this detail, really foreign to my thesis, because it seems important to record an inheritance so marked. The birds never learned to do more with threads than is here described, though they were ultimately allowed a room to live in with branches of trees to alight on, etc., and at least one of them laid eggs in an artificial nest.

On February 16, 1896, I took the birds by train from Boston to New York, where they spent the succeeding months until May 6 in a room in a large hotel. I wish to emphasize again two facts: both birds were females though I was not absolutely sure of it at this period, and, so far as I am aware, they heard no birds sing after I took them from their parents when about five days old, until after I took them to the country again on May 6, as will presently be related.

After reaching New York it was found expedient to keep them in separate cages when confined, though they were daily allowed much liberty at large in the room. During the last of February a partial moult occurred in both birds. This was chiefly the feathers of the head, throat and back. The wing and tail feathers were not shed.

Till now the two birds had looked so much alike, that in order to readily distinguish them I had early in October clipped the tips of the secondary feathers in one of Timmy's wings. This was a distinct mark even with the wings closed. But with the moult I am about to discuss, the birds ceased to be alike in appearance and were readily recognized.

Timmy in this moult acquired a distinct black throat patch, some black arrow-shaped marks in the feathers of the top of the head and decidedly dusky patches about

the region of the ears. The throat patch extended over the throat proper. The entire period taken in completing this moult was about three weeks.

The other bird, Driver, did not acquire any decided black marking about the head, throat or ears, and only showed a few scattered tiny black feathers.

Before this moult was quite completed, during the latter part of February, the birds began to sing. The interval between the singing was sometimes several days, and only a very few minutes in each day were devoted to song. This song was very low and soft, and more or less broken, reminding one of the song of the white-throated sparrow (*Z. albicollis*) as it is heard during the fall and in the early spring migrations.

Timmy was the first to sing in this way, and the period of song when noticed was brief, not lasting more than about one minute. The song was not heard again for several days. Then it became of daily occurrence, and was gradually more prolonged and better sustained. About five days after Timmy began to sing, Driver sang also. Driver soon became the chief singer, so that Timmy's weaker song was not so noticeable. But both increased in volume, and frequency all through the month of March, and during April and the first half of May while daylight lasted, the song was incessant in both birds. It was now a loud clear series of notes of great brilliancy, and poured forth in such rapid succession as to be like that of the house wren (*T. ædon*) in the intervals, and lasting about as long as the warble of that bird. Except for the 'rattle' which was now and then a part of the repertoire, this song had nothing in it that reminded one of the song of the Baltimore oriole as heard in New York, Massachusetts or at any point where the birds occur. Through the second week in May, the song of both birds gradually diminished.

I could generally, during the height of the song season, start the birds to sing by going to their cages, speaking to them and whistling a few notes. Here it seems essential to emphasize the fact that I in no way trained them to sing and made no effort to start them in song till long after their method of singing was established. In fact, the quality and phrasing of their singing was of such a character that none save an expert whistler could reproduce it.

Early in May of 1896 I took the birds to the country near New York, where we remained until July 20, 1897, a period of some fourteen months; then I moved to Princeton, New Jersey, where the remainder of their lives was passed. Both birds died during the winter of 1899-1900, apparently of old age.

To go back to the time of departure from New York in the spring of 1896. As has been stated, the birds' song became less frequent by the first week in May, and by the twentieth of that month they had ceased to sing. On June 6 I noticed the first signs of the summer moult and in a very few days it was in full progress.

It may be well to indicate some of the details of the change, though this is a divergence from the chief subject. Also, it should be borne in mind that native birds kept in confinement are generally about a month earlier in moulting and also in the song season, than are the representatives of the same species at liberty out of doors. This applies to all the species I have kept in confinement and when the birds are perfectly normal and healthy—so sound in health as to *breed in captivity*, which seems a good criterion. As examples, I may mention the bluebird (*S. sialis*), robin (*M. migratoria*), wood thrush (*H. mustelina*), catbird (*G. carolinensis*), brown thrasher (*H. rufus*), and the orchard oriole (*I. spurius*), all of which I have had live and breed and

go through the song and moult seasons year after year in captivity.

The moulting period of the two orioles occupied a month, and early in July both were in most exquisite fall plumage. The deeper orange and rusty tint that is so characteristic of the species, and the suffusion of the black areas on the throat, were as marked and fine in detail as in wild birds. At this moult for the first time the larger wing and all the tail feathers were shed and replaced. The two birds were marvels of beauty at all times, but just after the full summer moult they filled those who saw them with admiration and wonder. After the moult there was a secondary song season of short duration. The song was of the same character, but not so prolonged or elaborate.

So I have endeavored to give an idea of a year, or rather more, of these birds' lives, and the succeeding years to the end were but repetitions with but slight variation.

Each year the wearing of the tips of the feathers was apparent in January, and a partial moult such as I have described took place late in that month or in February. Then began again the peculiar low soft song at infrequent intervals, presently becoming noticeable in volume and occurrence, till the song wave reached its height and died away. Each early June found the birds putting on an entirely new garment of feathers.

I have spoken before in this paper of the observations of a second generation. I find that this perhaps conveys a wrong impression. Let me say at once that the second generation consisted of a brood of young orioles in no way related to Timmy or Driver. However, for the purpose of my subject, really these were a second generation, of birds of a given kind, subject to the influence of older birds of their own species.

On June 15, 1897, when Timmy and

Driver had passed through the song seasons and had a well-established song formula of their own, I obtained a brood of Baltimore orioles which I believed to be about six days old. The birds were secured at South Orange, N. J., a point several hundreds of miles from the birthplace of my original birds, Timmy and Driver. I shall distinguish these birds, when speaking of them, as the brood of 1897. They were reared in the same way that the other orioles had been, except that they had the *society of, and were closely associated during their early lives with*, the two older orioles.

The moults occurred at the same intervals that I have indicated, and by the winter of 1897-1898 I was able to distinguish the sexes of my four new birds by the characteristics that correlate with sex. Three were males and assumed full nuptial plumage by a partial moult in late January and part of February. The fourth bird was a female.

On my coming to live in Princeton when these 1897 orioles were about seven weeks old, they, as well as Timmy and Driver, had an especial room given over to their use, and from that time on the birds knew little or nothing of cage life.

After the spring or, rather, late winter moult of 1898, Timmy and Driver began to sing as they had done in the two previous years. At this time friends, good field ornithologists, familiar with the conventional song of the Baltimore oriole, heard them both sing, and not having up to that time seen the birds, were at a loss to identify the song as being like anything they had ever heard.

Soon after Timmy and Driver began to sing, the 1897 birds one by one joined, and in a month all were singing a song not to be distinguished from that of the two older birds. They outlived Timmy and Driver a year or more and always sang as I believe they had been taught by older birds of their

own kind. In short, only six orioles have ever sung this song, for I pursued the experiment no farther, other matters interfering.

My conclusion is that two birds, *isolated from their own kind and from all birds*, but with a strong inherited tendency to sing, originated a novel method of song, and that four birds, *isolated from wild representatives of their own kind, and associated with these two who had invented the new song*, learned it from them and never sang in any other way.

WILLIAM E. D. SCOTT,
Curator of Ornithology.

PRINCETON UNIVERSITY.

THE BOTANICAL SOCIETY OF AMERICA.

THE Botanical Society of America met in business sessions in Room 4 of the High School Building, Denver, Col., August 27 and 28, 1901, and presented its scientific program in joint session with Section G of the A. A. A. S. in the same place on August 28. The Presidential address on 'The Problems and Possibilities of Systematic Botany,' by Professor B. L. Robinson, was read by Dr. J. M. Coulter. The following program was presented:

'The Fundamental Phenomena of Vegetation': F. E. CLEMENTS.

'The Physical Basis of Ecology': F. E. CLEMENTS.

'A System of Nomenclature for Phytogeography': F. E. CLEMENTS.

'The Plant Formations of the Rocky Mountains': F. E. CLEMENTS.

'Early Winter Color of the Plant Formations of the Great Plains': C. E. BESSEY.

'The Anatomy of the Embryo and Seedling of *Tsuga Canadensis* Carr' (by invitation): W. A. MURRILL.

'Clues to Relationships among Heteroecious Plants': J. C. ARTHUR.

'The Thermal Relations of Vegetation': D. T. MACDOUGAL.

'The Application of Ecology in Taxonomy': F. E. CLEMENTS.

'Some of the Changes now taking place in a Forest of Oak Openings': W. J. BEAL.

'The Life-History of *Vittaria Lineata*': E. G. BRITTON and A. TAYLOR.